

I CLAIM:

1. A method of making an electron emissive material, comprising:

providing a plurality of pixels of the electron emissive material, each pixel having at least one different characteristic from any other one of the plurality of pixels; and

- 5 measuring at least one property of each pixel.

2. The method of claim 1, wherein the at least one characteristic comprises at least one of stoichiometry and composition.

3. The method of claim 2, wherein the at least one property comprises work function.

- 10 4. The method of claim 3, wherein the step of providing comprises:

providing a first dopant to a first pixel of a host material;

providing a second dopant of a different type or concentration than the first dopant to a second pixel of the host material;

- 15 reacting the dopants with the host material to provide a first and a second pixel of an array of pixels of the electron emissive material.

5. The method of claim 4, wherein the step of providing further comprises:

- 20 providing a plurality of dopants to the array of pixels of the host material, wherein a dopant provided to each pixel is of a different type or concentration than a dopant provided to other pixels; and

reacting the dopants with the host material to provide the array of pixels of the electron emissive material.

6. The method of claim 5, wherein:

each pixel of the host material comprises a triple oxide comprising barium oxide, strontium oxide and calcium oxide; and

the dopant comprises at least one of rubidium, iridium, cesium, scandium and rare earths.

5 7. The method of claim 6, further comprising:

providing a different concentration of the dopants to each pixel of the host material having a same composition and stoichiometry;

reacting the dopant and the host material to form the array of pixels where pixel each pixel has a different composition or stoichiometry from any other one of the plurality of pixels.

10 8. The method of claim 7, further comprising:

providing a liquid solution of the dopant in a solvent into wells in a top portion of the host material of each pixel; and

heating the pixel array to react the dopant and the host material.

15 9. The method of claim 8, further comprising:

providing a block of a host material; and

dicing the block into a plurality of pixels of host material.

10 10. The method of claim 8, further comprising:

20 providing a suspension containing a starting metal oxide powder into a plurality of cavities on a first substrate; and

heating the suspension to provide the host material pixel array, wherein each pixel is located in a respective cavity.

11. The method of claim 10, further comprising:

25 providing a host material base connecting the plurality of pixels located in the plurality of cavities on the first substrate;

removing the host material from the first substrate; and

placing the base onto a second substrate such that the plurality of pixels are distal from the second substrate.

12. The method of claim 3, wherein the step of providing
5 comprises:

providing a first pixel of a host material;

providing a second pixel of the host material having a different composition or stoichiometry than the first pixel.

13. The method of claim 12, wherein the step of providing further
10 comprises providing an array of a plurality of emissive material pixels, each pixel having a different composition or stoichiometry than the other pixels of the array.

14. The method of claim 13, further comprising:

providing a particulate material having a different composition or stoichiometry from a plurality of independent particulate injectors; and

15 heating the particulate material to provide the array of emissive material pixels.

15. The method of claim 14, wherein:

the emissive material comprises $(A_{1-x}, Ca_x)_p (Ta_{1-y}, W_y)_q O_{r+iy}$, wherein A comprises one of barium or a combination of barium and strontium, $p=2-6$; $q=2-6$;

20 $r=4-12$; $0 \leq x < 0.5$; and $0 \leq y < 1$; and

each pixel has a different value of at least one of p, q, r, x and y from the other pixels.

16. The method of claim 15, wherein:

the emissive material comprises $(A_{1-x} Ca_x)_6 (Ta_{1-y} W_y)_2 O_{11+y}$, where
25 least one of x or y is greater than zero;

each pixel has a different value of at least one of x and y from the other pixels;

$$0 \leq x \leq 0.4; \text{ and}$$

$$0 \leq y \leq 0.75.$$

5 17. The method of claim 15, wherein:

the emissive material comprises Y_2O_3 and La_2O_3 ; and

each pixel contains a different molar ratio of Y_2O_3 to La_2O_3 .

18. The method of claim 17, wherein the emissive material further comprises a material containing barium and oxygen.

10 19. The method of claim 3, wherein the measurement comprises measuring the work function of the emissive material using Auger spectroscopy, scanning tunneling microscopy, electrostatic force microscopy or atomic force microscopy.

15 20. The method of claim 3, wherein the measurement comprises measuring the work function of the emissive material using a Kelvin probe.

21. An array of an electron emissive material pixels made by the method of claim 3.

22. The method of claim 3, further comprising:

20 selecting the composition and the stoichiometry of a pixel having a desired value of work function;

producing an electron emissive material having the selected composition and stoichiometry; and

placing the electron emissive material onto an electrode of a fluorescent lamp.

23. A fluorescent lamp, comprising:

a shell;

a phosphor formed on an inner surface of the shell;

at least one electrode; and

an electron emissive material whose composition was determined by the method of claim 22.

24. A method of determining a work function of a plurality of pixels of an electron emissive material, comprising:

providing an array of pixels of a first material on a first substrate, each pixel having at least one different characteristic from any other one of the plurality of pixels; and

measuring the work function of each pixel on the first substrate using a work function measurement device.

25. The method of claim 24, wherein:

the first material comprises a ceramic electron emissive material; and

the work function measurement device comprises a Kelvin probe.

26. The method of claim 25, wherein the at least one characteristic comprises composition or stoichiometry.

27. The method of claim 26, wherein the electron emissive material is selected from a group consisting of:

(a) barium oxide, strontium oxide and calcium oxide;

(b) yttrium oxide and lanthanum oxide; and

(c) $(A_{1-x}Ca_x)_6(Ta_{1-y}W_y)_2O_{11+y}$, wherein A comprises one of barium or a combination of barium and strontium; $0 \leq x < 0.5$; $0 \leq y < 1$; and at least one of x and y is greater than zero.

28. The method of claim 25, further comprising:

positioning a Kelvin probe tip over a first pixel;

measuring the work function of the first pixel;

moving the first substrate relative to the Kelvin probe tip, such that the Kelvin probe tip is positioned over a second pixel; and

5 measuring the work function of the second pixel.

29. The method of claim 25, further comprising:

positioning a plurality of Kelvin probe tips over a plurality of respective pixels; and

simultaneously measuring the work function of the plurality of pixels.

10 30. The method of claim 24, wherein the work function measurement device comprises a scanning tunneling microscope.

31. A Kelvin probe combinatorial testing system, comprising:

a Kelvin probe apparatus;

15 a first substrate adapted to support a plurality of pixels of a material to be tested, each pixel having at least one different characteristic from any other one of the plurality of pixels; and

20 a computer electrically connected to the Kelvin probe apparatus containing software which analyzes a work function measured on the plurality of pixels and which provides a visual, electronic or printed output of the work function of each pixel.

32. The system of claim 31, further comprising a plurality of pixels of an electron emissive material to be tested, each pixel having at least one different characteristic from any other one of the plurality of pixels, located on the first substrate.

25 33. The system of claim 31, further comprising a driver which is adapted to move the first substrate such that a tip of the Kelvin probe is positioned over a particular pixel.

34. The system of claim 31, further comprising a plurality of Kevin probe tips positioned over a plurality of the first substrate locations adapted to support a pixel.

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